NOTES ON THE HABITS OF CAMBARUS IMMUNIS HAGEN.

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In the present notes I intend to give only a few observations made on the habits of one of our common crawfishes, *Cambarus immunis* Hagen. The material which I have examined seems quite variable, and a part of it would probably fall under Faxon's variety, *spinirostris*. It does not embrace all the data I have at hand, and as more is being collected as rapidly as opportunities for field work are presented, I hope in the near future to give a much more complete account of the habits of this and other forms. These few points are presented here simply because they seem to throw some light upon one or two questions concerning the habits of the crawfish, a field which I feel sure is deserving of careful study.

C. immunis is decidedly a mud-loving species. Faxon[1] says: "Mr. H. G. Hubbard has found it in muddy pools and ditches connected with the Detroit River, Michigan. According to Mr. Hubbard, it does not form burrows but conceals itself among weeds." Herrick,[2] in his description of *C. signifer* [= *C. immunis*], says: "Found by hundreds in a shallow pool known as Grass Lake in Richfield, Hen. County." Forbes[3] says: "This is the commonest species of central Illinois. It is especially frequent in the muddy ponds of the prairies, whence it may be drawn by the hundred with a small seine." Hay[4] says: "This species is a mud-lover, being found in great numbers in muddy

[1] Faxon, Walter. A Revision of the Astacidæ, *Mem. Mus. Comp. Zoöl. Harvard College*, vol. x (1885), No. 4.

[2] Herrick, C. L. Papers on the Crustacea of the Fresh Waters of Minnesota, *Tenth Rept. on the Geol. of Minn.*, 1882.

[3] Forbes, S. A. List of Illinois Crustacea, with Descriptions of New Species, *Bull. Ill. State Lab. of Nat. Hist.*, vol. i, No. 1.

[4] Hay, W. P. The Crawfishes of the State of Indiana, *Twentieth Ann. Rept. Ind. Geol. Survey*, 1896.

ponds in the early spring. I have always found them in the greatest abundance in ponds which became perfectly dry during the summer months, but where the crawfish go during this time I have never been able to ascertain. Doubtless great numbers of them are eaten by birds and other animals, and great numbers of them perish; yet by the next spring they are as abundant as ever and of about the same size."

C. immunis is our most common species in Douglas County, Kansas, and is found in almost precisely the same habitat as reported above for Illinois, Indiana, Michigan, and Minnesota. Roadside ditches and ponds in pastures are favorite places. In this county we have ponds in an old river bed which contain immense numbers of this species. These ponds are six to eighteen inches deep, depending upon the dryness of the season. They are very muddy and have usually in the shallower parts, which are apt to become dry during the summer, a rank growth of Polygonum and plants of like habit. From such a pond I took, one day in October, 1898, in company with Mr. C. D. Bunker and another collector, about fifteen hundred specimens, of which only a very few were less than two and one-half inches in length. There were not more than a half dozen small specimens in the whole lot; in other ponds, however, I have made collections which showed almost all stages of development. In many of the ponds *C. immunis* seems to be the only species, but in others we find also *C. gracilis* Bundy and *C. virilis* Hagen (?), but these do not occur in nearly so great numbers as does *C. immunis*.

According to my observations, *C. immunis* is a burrowing and, at least to a certain extent, a chimney-building species. Burrowing, however, appears to be only resorted to when there is danger of the drying up of the ponds or on the approach of winter. Lack of opportunity for examining the ponds in all different conditions without doubt accounts for the failure of Hubbard[1] or Hay[2] to observe the burrowing habit of this species. Hay's suggestion of crawfish perishing upon the drying up of the ponds seems to me to be largely ungrounded, since I have never found any considerable numbers of dead ones in

[1] Faxon, W. *Loc. cit.* [2] Hay, W. P. *Loc. cit.*

many places which I have visited in all stages of drying up. Possibly birds may eat a few, but probably these are mostly water birds which could easily get the crawfish in the shallow water at any time.

In early September, 1900, I visited a pond, which earlier in the season had many crawfish in it, and found there were many burrows around the edge and but few animals in the pond. Upon digging out one of these burrows, which had a chimney about four inches high and five inches in diameter at the base, I found a large first-form male and a somewhat smaller female. The burrow was about fifteen inches deep and about one and one-half inches in diameter; at the bottom it was expanded into a cistern-shaped chamber about three and one-half or four inches in diameter. It appeared that the burrow had been carefully sealed by the animals. Some time later I examined the pond when it was almost dry and found no crawfish, but plenty of chimneys in various stages of disintegration. At about the same time in another pond, which contained more water, the crawfish were abundant. About the middle of October, 1900, I examined the burrows of *C. immunis* around the first pond mentioned above. Some of the burrows had chimneys, others were simply open at the top; probably those which had no towers were old burrows whose chimneys had been disintegrated by the weather. The chimneys were of different forms, some being almost regular, while it was evident that others were formed simply by the mud being thrown out of the burrow. Sometimes the mud appears to be just thrown out on one side, then, after a considerable amount of material has accumulated, the remainder is thrown out wherever convenient, forming an irregularly circular mound one to three inches high and six to nine inches across, or sometimes a long ridge with the shaft in the middle, the material here being thrown out in both directions. Sometimes the work is stopped before enough mud has been removed to make it inconvenient to throw it all to one side; thus forming a crescent-shaped pile. The highest chimneys noticed were about five inches high and three inches in diameter at the top. These were sometimes much inclined from the perpendicular. On the

whole, I think that, for this species at least, the theory of Tarr[1] and Shufeldt,[2] that the chimney is simply the deposition of the material brought up from the burrow, is correct. The mud is brought up in very soft condition, and I think that even if the burrow were made in the sloping side of a ditch there would be little danger of the pellets rolling down, as suggested by Abbott;[3] in fact I have examined several burrows on the sides of ditches, presumably in the same kind of position as those examined by Mr. Abbott, and I have not been able to convince myself that anything except the easiest method of disposing of material from the burrows could have prompted the animal to build chimney-like structures. The quantity of material brought up is very considerable, amounting in some cases to nearly two hundred cubic inches.

As suggested above, the accidental sealing of the burrows would seem to be impossible. I believe that I found the "dumps" in enough different stages of construction to warrant the conclusion that the opening through the tower is left open until the last, when it is closed by stopping with mud brought from below. The opening is thus filled solidly from the top, or near the top, to almost the level of the ground, where the shaft has a concave hemispherical end, which is not so smooth as Shufeldt's[4] description of the burrow of *C. diogenes* would seem to indicate. And I cannot agree with him that the animal might have used the lateral tail fins in finishing this off, since I have never seen impressions in the mud which would indicate such a method, while there are many marks which would indicate that the animal had run the ends of the chelæ into the soft mud. In at least one case which I examined, the burrows had been filled to somewhat below the surface of the ground with clay so tightly packed that it would seem impossible that it might have fallen in by accident. The shaft usually goes straight down, but in some

[1] Tarr, Ralph. Habits of Burrowing Crayfish in the United States, *Nature*, vol. xxx (1884), p. 127.

[2] Shufeldt, R. W. *Chapters on the Natural History of the United States*. New York, 1897.

[3] Abbott, C. C. Are the Chimneys of Burrowing Crayfish Designed? *Amer. Nat.*, vol. xviii (1884), p. 1157.

[4] Shufeldt, R. W. *Loc. cit.*

cases may be somewhat sinuous. They are quite deep, one being followed down for four feet without reaching the end. I am not able to convince myself that there was a ledge upon which the animal could rest, as stated by Hubbard[1] for *C. argillicola*, although in some cases the burrow seemed to be expanded in a way which might serve for this purpose. In one case examined quite early in the fall, the main shaft went straight down; at a distance of about six inches from the surface a branch went off at almost right angles and ended somewhat higher than it originated about eighteen inches from its connection with the main shaft. It might seem that the animals do not like to stay down in the bottom of the burrow very long, at least early in the fall, since when a small excavation extending somewhat below the water mark was made in one of the burrows the animal came to the top and darted back two or three times when I attempted to catch him, which I finally succeeded in doing. The burrow was left for a few minutes and when again examined a medium-sized female had crawled out of the water and was standing on the almost perpendicular side of the excavation.

Hay's[2] theory, that the burrows of *C. diogenes* are made to escape the dry months of summer, seems undoubtedly the explanation for the summer burrowing of this species, while of course the purpose of burrows made or enlarged upon the approach of winter is evident. It is certain that the burrows are not adopted as retreats, while the eggs are being hatched, for I have taken the females in the open ponds in the fall, apparently soon after the eggs were laid, and they come out early in the spring — about March 20 — to complete the process of hatching the eggs.

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[1] Faxon, Walter. Descriptions of New Species of Cambarus, *Proc. Am. Acad. Arts and Sci.*, vol. xx (1884), p. 116. [2] Hay, W. P. *Loc. cit.*